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## XIII.

## THE WEDGE PHOTOMETER.

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MUCH attention has recently been directed to the use of a wedge of shade glass as a means of measuring the light of the stars. While it has been maintained by various writers that this device is not a new one, the credit for its introduction as a practical method of stellar photometry seems clearly to belong to Professor Pritchard, Director of the University Observatory, Oxford. Various theoretical objections have been offered to this photometer, and numerous sources of error suggested. Professor Pritchard has made the best possible reply to these criticisms by measuring a number of stars, and showing that his results agreed very closely with those obtained elsewhere by wholly different methods. His instrument consists of a wedge of shade glass of a neutral tint inserted in the field of view of the telescope, and movable so that a star may be viewed through the thicker or thinner portions at will. The exact position is indicated by means of a scale. The light of different stars is measured by bringing them in turn to the centre of the field, and moving the wedge from the thin towards the thick end until the star disappears. The exact point of disappearance is then read by the scale. The stars must always be kept in the same part of the field, or the readings will not be comparable. By a long wedge the error from this source will be reduced. A second wedge in the reversed position will render the absorption uniform throughout the field. Instead of keeping the star in the same place by means of clockwork, the edges of the wedge may be placed parallel to the path of the star, when the effect of its motion will be insensible. To obtain the best results the work should be made purely differential, that is, frequent measures should be made of stars in the vicinity assumed as standards. Otherwise large errors may be committed, due

to the varying sensitiveness of the eye, to the effect of moonlight, twilight, &c., and to various other causes.

A still further simplification of this photometer may be effected by substituting the diurnal motion of the earth for the scale as a measure of the position of the star as regards the wedge. It is only necessary to insert in the field a bar parallel to the edge of the wedge and place it at right angles to the diurnal motion, so that a star in its transit across the field will pass behind the bar and then undergo a continually increasing absorption as it passes towards the thicker portion of the wedge. It will thus grow fainter and fainter, until it finally disappears. It is now only necessary to measure the interval of time from the passage behind the bar until the star ceases to be visible, to determine the light. Moreover all stars, whether bright or faint, will pass through the same phases, appearing in turn of the 10, 11, 12, &c., magnitude, until they finally become invisible. For stars of the same declination, the variation in the times will be proportioned to the variations in the thickness of the glass. But since the logarithm of the light transmitted varies as the thickness of the glass, and the stellar magnitude varies as the logarithm of the light, it follows that the time will vary as the magnitude. For stars of different declinations, the times of traversing a given distance will be proportional to the secant of the declination. If  $\delta, \delta'$  are the declinations of two stars having magnitudes  $m$  and  $m'$ , and  $t, t'$  are the times between their transits over the bar and their disappearances, it follows that  $m' - m = A (t \sec \delta - t' \sec \delta')$ . For stars in the same declination calling  $A \sec \delta = A'$  we have  $m' - m = A' (t - t')$ . Accordingly the distance of the bar from the edge of the wedge is unimportant, and, as in Professor Pritchard's form of the instrument, it is only necessary to determine the value of a single constant,  $A$ . Various methods may be employed to determine this quantity. Professor Pritchard has recommended reducing the aperture of the telescope. This method is open to the objection that the images are enlarged by diffraction when the aperture is diminished; constant errors may thus be introduced. Changing the aperture of a large telescope requires some time, and in the interval the sensibility of the eye may alter. These difficulties are avoided by the following method, which may be employed at any time. Cover the wedge with a diaphragm in which are two rectangular apertures, and place a uniformly illuminated surface behind it. Bring the two rectangles into contact by a double image prism, and measure their relative light by a Nicol. From

the interval between the rectangles and the focal length of the telescope the light in magnitudes corresponding to one second, or  $A$ , may be deduced. Perhaps the best method with a small telescope is to measure a large number of stars whose light has already been determined photometrically, and deduce  $A$  from them.

The great advantage claimed for this form of wedge photometer is the simplicity of its construction, of the method of observing, and of the computations required to reduce the results. It may be easily transported and inserted in the field of any telescope like a ring micrometer. The time, if the observer is alone, may be taken by a chronograph or stop-watch. Great accuracy is not needed, since if ten seconds correspond to one magnitude, it will only be necessary to observe the time to single seconds. The best method is to employ an assistant to record and take the time from a chronometer or clock. If the stars are observed in zones, the transits over the bar serve to identify or locate them as well as to determine their light. A wedge inserted in the field of a transit instrument will permit the determination of the light of each star observed without interfering with the other portion of the observation. If the stars are all bright, time may be saved by dispensing with the thin portion of the wedge. In equatorial observations of asteroids the light may be measured photometrically with little additional expenditure of time. Perhaps the most useful application would be in the observation of zones. When the stars are somewhat scattered it would often happen that their light might be measured without any loss of time. By this instrument another field of usefulness is opened for the form of horizontal telescope advocated at a former meeting of this Academy (Proc. Amer. Acad. XVI. 364). Very perfect definition would not be required, since it would affect all the stars equally. To an amateur who would regard the complexity of an instrument as a serious objection to it, a means is now afforded of easily reducing his estimates of magnitude to an absolute system, and thus rendering them of real value.